PHYSICS

Gravity

- **The Universal Law of Gravity [_____] or [_____]**
  - **G = 6.67 x 10^{-11} _____**
  - **Henry _____ measured this with a large torsion balance in eighteenth century.**
  - **Philipp von _____ measured it with a 6 ton lead ball under a balance.**

- **Let's calculate the mass of the Earth!**
  - **First, we ask the question, "What is the force on a 1kg mass at the surface of the earth?"**
    - **Since f=ma and a=g=9.8m/sec^2 (at the surface of the earth)**
      - **then for a 1 kg mass, f = 9.8 kg m/sec^2**
      - **or f = _____**
    - **Then, since $f = Gm_1m_2 / d_2$**
      - **and since the earth's radius is 6.64 x 10^6m (or 8,000 miles)**
      - **and since G=6.67 x 10^{-11} N m_2/kg_2**
      - **then 9.8N=6.67 x 10^{-11} N m_2/kg_2(1kg x m_e / (6.64 x 10^6m)$_2$)**
      - **or m_e=_____**

- **The Inverse Square Law [_____]**
  Gravity, Light, E&M, Heat… all obey this law because of the shape of space.

- **Weightlessness & _____**
  - **3 conditions for weightlessness: _____, _____, _____ .**
  - **Said another way, "When would you depress a spring scale?"**

- **The Moon & The Tides**
  - **The bulges of the tides are from _____ _____ of the Moon.**
  - **The ocean is about _____ meter higher from the Moon.**
  - **The Sun's _____ _____ for the Earth is 180 times stronger than the Moon's.**
  - **So why doesn't the Sun cause tides?**
  - **It does. It has _____ the effect of the Moon.**
  - **Even though the Moon is less strong – it is _____ and _____ . The Sun is ____ and _____ .**
  - **The moon also has a tide – it pulls a bulge toward the earth and the center of gravity, too! It causes a torsion that keeps one side of the moon always facing the earth. Earth days are gaining 2 milliseconds/century due to this attraction from the moon – and in a few billion years, at this rate, our day will be a month and we will always face one side to the moon.**

- **Einsteins' Theory of Gravity - Curved Space-Time …**
  - **Can you explain how a curvature in space could cause the same result as gravity?**

- **Black Holes … objects where _____ exceeds the _____ !**
  - **If the Sun < ____ km wide, or the earth was the size of a _____ , you'd have a black hole.**
  - **Wormholes: black holes that open into _____ , remain speculative.**

- **Universal Gravitation**
  - **_____ is the reason the earth is round!**
  - **Within our solar system planets pull on each other – these cause _____ .**
  - **By 1840's Uranus' _____ could not be explained by other planets – predicting another!**
    - **Englishman and Frechman sent letter to Greenwich observatory, calculating _____ planet.**
    - **When the letters were investigated, _____ was discovered that night!**
    - **Further perturbation refinements led to _____ (which may not be a planet, now).**
  - **We think our planets formed from the gravitational attraction of interstellar _____ .**
  - **Gas increases _____ momentum speeding up as it gets closer together.**
  - **Few theories have affected humankind as much as Newton's _____ .**